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(54) Title: OPTICAL CODE READING DEVICE HAVING MORE THAN ONE IMAGING ENGINE
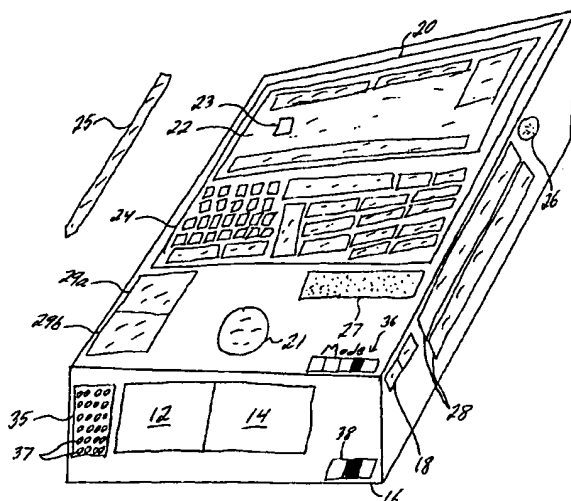
(57) Abstract: A mobile computing device is provided having more than one imaging engine, and preferably, two imagining engines. Switching circuitry is provided for switching between the two imaging engines. Each imaging engine is optimized for use in specific applications and includes different specifications from the other imaging engine. Preferably, one imaging engine is optimized to provide higher resolution images than the other imaging engine, and one imaging engine is optimized to focus an object located 7.50 to 12.50 cm from the mobile computing device (near-to-mid range imaging), while the other imaging engine is optimized to focus an object located from 12.50 cm to infinity from the mobile computing device (mid-to-far range imaging). One imaging engine preferably includes a color image sensor, while the other imaging engine includes a black and white image sensor.

OPTICAL CODE READING DEVICE HAVING MORE

THAN ONE IMAGING ENGINE

BACKGROUND OF THE INVENTION

1. Field of the Invention

5   This invention relates to imaging in optical code reading devices.   Aspects of the

invention are particularly useful in solid state, area image sensor based, handheld code readers

which are positioned at variable orientations and distances with respect to a target code.

Aspects of the invention are also particularly useful in other digital, imaging devices, such

personal digital assistants (PDAs), digital video cameras, scanners, pagers, video telephones,

10   cellular telephones, hand held computers, and hand held data capture devices.

2. Description of the Related Art

Optical codes are patterns made up of image areas having different light reflective or

light emissive properties, which are typically assembled in accordance with a priori rules.

The term "barcode" is typically used to describe certain kinds of optical codes. The optical

15   properties and patterns of optical codes are selected to distinguish them in appearance from

the background environments in which they are used. Devices for identifying or extracting

data from optical codes are sometimes referred to as "optical code readers" of which barcode

scanners are one type.

Optical code readers are used in both fixed or portable installations in many diverse

20   environments such as in stores for check-out services, in manufacturing locations for work

flow and inventory control and in transport vehicles for tracking package handling. The

optical code can be used as a rapid, generalized means of data entry, for example, by reading

a target barcode from a printed listing of many barcodes. In some uses, the optical code

reader is connected to a portable data processing device or a data collection and transmission

device. Frequently, the optical code reader includes a handheld sensor which is manually directed at a target code.

Most conventional optical scanning systems are designed to read one-dimensional barcode symbols. The barcode is a pattern of variable-width rectangular bars separated by
5 fixed or variable width spaces. The bars and spaces have different light reflecting characteristics. One example of a one dimensional barcode is the UPC/EAN code used to identify, for example, product inventory. An example of a two-dimensional or stacked barcode is the PDF417 barcode. Another conventional optical code is known as "MaxiCode". It consists of a central finder pattern or bull's eye center and a grid of hexagons surrounding
10 the central finder.

It is noted that the objects of the inventions disclosed herein are applicable to optical code readers, in general, without regard to the particular type of optical codes which they are adapted to read. The invention described may also be applicable to some associated image recognition or analysis.

15 Most conventional scanning systems generate one or more beams of laser light which reflects off a barcode symbol and back to the scanning system. The system obtains a continuous analog waveform corresponding to the light reflected by the code along one or more scan lines of the system. The system then decodes the waveform to extract information from the barcode. A system of this general type is disclosed, for example, in U.S. Pat. No.
20 4,251,798, assigned to Symbol Technologies, Inc. A beam scanning system for detecting and decoding one and two dimensional barcodes is disclosed in U.S. Pat. No. 5,561,283, also assigned to Symbol Technologies, Inc.

Such scanning systems are deployed in handheld units which may be manually pointed at the target. Often an individual scanner is a component of a much larger system

including other scanners, computers, cabling, data terminals, etc. Such systems are frequently

designed and constructed on the basis of mechanical and optical specifications for the

scanning engine, sometimes called "form factors". One such form factor is the SE1200 form

factor designed by Symbol Technologies, Inc.

5   Optical codes can also be read by employing optical code readers having an imaging

engine. An imaging engine includes an image sensor having a two-dimensional array of cells

or photo sensors, such as an area charge coupled device (CCD), which correspond to image

elements or pixels in a field of view of the imaging engine. The imaging engine further

includes a lens assembly for focusing light incident on the image sensor and associated

10   circuitry coupled to the image sensor.

The associated circuitry produces electronic signals corresponding to a two-

dimensional array of pixel information for the field of view. The electrical signals are

processed by a processor for extracting information indicative of the focus quality of an

image corresponding to the field of view.

15   An object of the present invention is to provide a more versatile optical code reader

than prior art optical code readers.

Another object of the present invention is to provide a mobile computing device, and

preferably, an optical code reading device, having more than one imaging engine, and

preferably, two imaging engines, where each imaging engine is optimized for use in specific

20   applications, such as reading optical codes, video teleconferencing, capturing biometric and

other images, taking digital still snapshots, and capturing a sequence of digital images

continuously or over a period of time (time lapse).

Another object of the present invention is to provide a mobile computing device

having more than one imaging engine, where each imaging engine is capable of automatically

focusing an image impinged on an image sensor and has a predetermined form factor, such as

the SE900 and SE1200 form factors which are utilized in currently deployed optical code

readers to increase the reliability, versatility and focusing ability of such readers.

SUMMARY OF THE INVENTION

5   In accordance with the present invention, a mobile computing device is provided

having more than one imaging engine and associated circuitry supported by a single housing.

The mobile computing device is preferably an optical code reading device with increased

functionality by having more than one imaging engine with different optical specifications.

The mobile computing device can also be a personal digital assistant (PDA), a digital camera,

10   a pager, a video telephone, a cellular telephone, a hand held computer, a hand held data

capture device, etc. Accordingly, each imaging engine is optimized for use in specific

applications, such as reading optical codes, video teleconferencing, capturing biometric and

other images, taking digital still snapshots, and capturing a sequence of digital images

continuously or over a period of time (time lapse). Other applications and features include

15   creating and transmitting video e-mail, performing video surveillance, and previewing and

storing images.

Additionally, one imaging engine is optimized to provide higher resolution images

than the other imaging engine by having a higher resolution photo detector array. For

example, the imaging engine for use in capturing biometric images is designed to provide

20   higher resolution images, while the imaging engine for use in reading optical codes is

designed to provide lower resolution images and includes laser aiming and illumination

assembly.

Further, one imaging engine is optimized to focus an object located 7.50 to 12.50 cm

(focal distance) from the mobile computing device (near-to-mid range imaging), while the

other imaging engine is optimized to focus an object located from 12.50 cm to infinity (focal

distance) from the mobile computing device (mid-to-far range imaging). Other optical

properties for each imaging engine are further contemplated, such as different depths of field

and fields of view. Additionally, one imaging engine preferably includes a color image

5   sensor, e.g., CIF (Color) CCD image sensor, while the other imaging engine includes a black

and white image sensor, e.g., VGA black and white CCD image sensor.

Each imaging engine (or only one imaging engine) is capable of automatically

focusing an image impinged on an image sensor by adjusting the position of at least one lens

of a lens assembly of the imaging engine. It is contemplated, however, that one or both of the

10   imaging engines are fixed focus-type imaging engines.

The mobile computing device further includes switching circuitry, such as a

multiplexer, for switching between the two imaging engines. A processor within the mobile

computing device is programmed with a set of instructions for automatically controlling the

switching circuitry via interface logic circuitry for switching between the two imaging

15   engines in accordance with a user-selected mode via a mode selection switch. For example, if

the user selects a biometrics mode, a signal is transmitted to the processor for switching

and/or using the imaging engine designed to provide a higher resolution image. If the user

selects a bar code reading mode, a signal is transmitted to the processor for switching and/or

using the imaging engine designed to provide a lower resolution image. Further, switching

20   between the two imaging engines can be manually performed via an imaging engine selection

switch.

Preferably, each imaging engine is configured and dimensioned to fit within a

predetermined form factor, such as the SE1200 form factor which is utilized in currently

deployed optical code readers for increasing the reliability, versatility and focusing ability of

such readers. The SE1200 form factor occupies a space of approximately 1-½ inch x 1 inch x ¾ inch. The predetermined form factors for placing therein each of the imaging engines can be oriented side-by-side such that the imaging engines contact each other, or in different areas of the housing such that the imaging engines do not contact each other. Therefore, the

5   imaging engines could be two single imaging engines or two connected imaging engines. It is, however, contemplated that the two imaging engines are integrated into one imaging engine.

Embodiments are provided herein where at least one of the imaging engines is movably mounted to the housing, and where at least one of the imaging engines is removably

10   connected to the housing. In these embodiments, the field of view of at least one of the imaging engines can be changed without moving the housing of the mobile computing device. The above and other embodiments of the invention will be described herein below with reference to the accompanying figures.

BRIEF DESCRIPTION OF THE DRAWINGS

15   Various embodiments of the invention will be described herein below with reference to the figures wherein:

FIG. 1 is a perspective view of a mobile computing device in accordance with one embodiment of the present invention;

FIG. 2 is a perspective view of an optical code reader in accordance with another

20   embodiment of the present invention;

FIG. 3 is a block diagram of the mobile computing devices of FIGS. 1 and 2;

FIG. 4 is a perspective view of a mobile computing device in accordance with another embodiment of the present invention; and

FIG. 5 is a perspective view of a mobile computing device in accordance with still

another embodiment of the present invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

The present invention provides a mobile computing device and method for performing

5   digital imaging where more than one imaging engine and associated circuitry are supported by

a single housing. Embodiments are provided herein where at least one of the imaging engines

is movably mounted to the housing (FIG. 4), and where at least one of the imaging engines is

removably connected to the housing (FIG. 5). In these embodiments, the field of view of at

least one of the imaging engines can be changed without moving the housing of the mobile

10   computing device.

In another embodiment, the mobile computing device is preferably an optical code

reader with increased functionality by having more than one imaging engine with different

optical specifications. The mobile computing device can also be (or behave as) a personal

digital assistant (PDA), a digital camera, a pager, a video telephone, a cellular telephone, a

15   hand held computer, a hand held data capture device, etc. Accordingly, each imaging engine

is optimized for use in specific applications, such as reading optical codes, video

teleconferencing, capturing biometric and other images, taking digital still snapshots, and

capturing a sequence of digital images continuously or over a period of time (time lapse).

Other applications and features include creating and transmitting video e-mail, performing

20   video surveillance, and previewing and storing images.

Additionally, one imaging engine is optimized to provide higher resolution images

than the other imaging engine by having a higher resolution photo detector array. For

example, the imaging engine for use in capturing biometric images is designed to provide

higher resolution images, while the imaging engine for use in reading optical codes is

designed to provide lower resolution images and includes laser aiming and illumination

assembly. Further, one imaging engine is optimized to focus an object located 7.50 to 12.50

cm (focal distance) from the mobile computing device (near-to-mid range imaging), while the

other imaging engine is optimized to focus an object located from 12.50 cm to infinity (focal

5   distance) from the mobile computing device (mid-to-far range imaging). Other optical

properties for each imaging engine are further contemplated, such as different depths of field

and fields of view. Additionally, one imaging engine preferably includes a color image

sensor, e.g., CIF (Color) CCD image sensor, while the other imaging engine includes a black

and white image sensor, e.g., VGA black and white CCD image sensor.

10   Each imaging engine (or only one imaging engine) of the mobile computing device is

capable of automatically focusing an image impinged on an image sensor by adjusting the

position of at least one lens of a lens assembly of the imaging engine. For example, as

described in a United States Patent Application filed on April 29, 2003 and assigned U.S.

Application Serial No. 10/425,344 and U.S. Provisional Patent Application No. 60/434,519

15   filed on December 18, 2002, the contents of both applications are incorporated herein by

reference. It is contemplated, however, that one or both of the imaging engines are fixed

focus-type imaging engines.

       With reference to FIGS. 1 and 2, there are shown perspective views of mobile

computing devices in accordance with two embodiments of the present invention. The

20   mobile computing devices are referenced generally by reference signs 10, 10'. Each includes

two imaging engines 12, 14 having different optical specifications and supported by a housing

16, 16'. Each imaging engine is structurally equivalent by having at least one image sensor

(not shown). Each image sensor includes an array of sensors for generating respective pixel

data indicative of incident light on the image sensor as known in the art.

The pixel data is processed by an internal or external processor for performing image

recognition and analysis or for decoding an optical code imaged by the image sensor, as

known in the art. It is within the scope of the present invention that after analyzing the pixel

data, if the focus quality or other parameter is outside a predetermined threshold focus range,

5   at least one lens of a lens assembly of one of the imaging engines 12, 14 is moved by an

amount determined by the processor by controllably actuating a lens guidance assembly. For

example, as disclosed in U.S. Patent Application Serial No. 10/425,344. The pixel data can

be analyzed in accordance with data processing methods, such as the methods disclosed in

U.S. Patent Application Serial No. 10/389,184, the contents of which are incorporated herein

10   by reference.

Preferably, each imaging engine is configured and dimensioned to fit within a

predetermined form factor, such as the SE1200 form factor which is utilized in currently

deployed optical code readers for increasing the reliability, versatility and focusing ability of

such readers. The SE1200 form factor occupies a space of approximately 1-½ inch x 1 inch x

15   ¾ inch.

The predetermined form factors for placing therein each of the imaging engines 12, 14

can be oriented side-by-side such that the imaging engines 12, 14 contact each other (as

shown by FIG. 1), or in different areas of the housing 16 such that the imaging engines 12, 14

do not contact each other (as shown by FIG. 2). Therefore, the imaging engines 12, 14 could

20   be two single imaging engines or two side-by-side connected imaging engines. It is, however,

contemplated that the two imaging engines 12, 14 are integrated into one imaging engine.

The housing 16 is preferably extremely rugged for enduring extreme temperatures and

multiple drops to a hard surface, such as a concrete surface.

The mobile computing devices 10, 10' further include I/O ports 18, such as an IrDA port, a display 20, such as a glass analog resistive touch panel with an LED backlight, a graphical user interface 22, a plurality of data entry keys 24, and a power source (not shown), such as a rechargeable/replaceable lithium ion battery. The graphical user interface 22 can be

5   used to initiate the execution of software applications to perform various functions, such as view live or recorded images obtained by the imaging engines 12, 14, wirelessly access the Internet or other network, check e-mail messages, compose a document, etc.

The data entry keys 24 are used to dial a telephone number when the mobile computing devices 10, 10' are used as a cellular telephone, and to search the Internet when

10   the mobile computing devices 10, 10' are used as an Internet access device. Images obtained by the mobile computing devices 10, 10' can be transmitted via the Internet or other network, such as paging and cellular networks. Accordingly, communication features, such as an antenna, phone and Ethernet jacks, an ISP, and a modem, for providing wireless communications via at least one of a plurality of communication protocols, such as CDMA,

15   TDMA, GSM, IEEE 802.11, Bluetooth, IMT 2000, CDMA2000, etc., are provided to the mobile computing devices 10, 10'.

Other features of the mobile computing devices 10, 10' include a writing stylus 25 for communicating with the graphical user interface 22, a microphone 26, a speaker 27, card slots 28, scan triggers 29a, 29b for triggering the two imaging engines 12, 14, respectively, and an

20   AC-DC converter (not shown) for powering the devices 10, 10' using an AC outlet. The mobile computing device 10 also includes a cursor control device 21, such as a mouse, for controlling a cursor 23 displayed by the graphical user interface 22, and an aiming and illumination assembly 35. The aiming and illumination assembly 35 includes a plurality of

lighting sources 37, such as laser LEDs, and can be integrated with one of the imaging engines 12, 14.

The mobile computing devices 10, 10' further includes an automatic focusing lens assembly 31 for automatically controlling movement of at least one lens of a lens assembly of

5   imaging engine 12, as shown by FIG. 3, to focus an image impinged on an image sensor, such as a CCD image sensor, of the imaging engine 12. It is contemplated that an automatic focusing lens assembly 31 can be provided for automatically controlling movement of at least one lens of a lens assembly of both imaging engines 12, 14.

It is further contemplated that the automatic focusing lens assembly 31 can be

10   configured for manually moving the at least one lens of the lens assembly of the imaging engine 12 for manually focusing the image impinged on the image sensor. Further still, it is contemplated that the automatic focusing lens assembly 31 is integrated with the imaging engine 12, and the integrated focusing lens assembly and imaging engine is dimensioned to fit within a predetermined form factor.

15   All of the various functions of the mobile computing devices 10, 10', including the selection and triggering of one of the imaging engines 12, 14 for imaging and the automatic control of the automatic focusing lens assembly 31, are performed by executing source code stored within at least one processor, such as processor 32 shown by FIG. 3, of the mobile computing devices 10, 10', or by other methods as known in the art. The mobile computing

20   devices 10, 10' further include an operating system executed by the at least one processor.

FIG. 3 is a block diagram of the mobile computing devices 10, 10'. Each imaging engine 12, 14 is connected to switching circuitry 30 which in turn is connected to a processor 32 via interface logic circuitry 34. The processor 32 controls the switching between the two imaging engines 12, 14 depending on the particular application the mobile computing device

10, 10' is performing or the operating mode the mobile computing device 10, 10' is set to. The interface logic circuitry 34 receives data, such as pixel data, from the imaging engines 12, 14 and transmits the data to the processor 32 for storage and/or processing.

The processor 32 is programmed with a set of instructions for automatically
5   controlling the switching circuitry 30 via the interface logic circuitry 34 for switching between the two imaging engines 12, 14 in accordance with a user-selected mode using a mode selection switch 36 or other selection means, such as by using the data entry keys 24. For example, if the user selects a biometrics mode, a signal is transmitted to the processor 32 for switching and/or using the imaging engine designed to provide a higher resolution image.
10   If the user selects a bar code reading mode, a signal is transmitted to the processor 32 for switching and/or using the imaging engine designed to provide a lower resolution image. The processor 32 also controls the aiming and illumination assembly 35 in accordance with the imaging engine selected and/or the operating mode selected.

The switching circuitry 30 can also be controlled by an imaging engine selection
15   switch 38 or other selection means, such as by using the data entry keys 24. The selection switch 38 can be switched from an "auto-select" position where the processor 32 determines which imaging engine to be used for imaging in accordance with the operational mode selected, to one of a "low resolution" position and a "high resolution" position for manually selecting one of the imaging engines 12, 14. That is, if the selection switch 38 is used to
20   manually select "low resolution", the processor 32 selects the imaging engine providing low resolution images. If the selection switch 38 is used to manually select "high resolution", the processor 32 selects the imaging engine providing high resolution images.

The switching circuitry 30 preferably includes a multiplexer under the control of the processor 32 via the interface logic circuitry 34 for multiplexing the two sets of pixel data or

signals received from the two imaging engines 12, 14 before transmitting one set of pixel data

or signals to the processor 32 via the interface logic circuitry 34 for image processing, such as

image recognition and analysis, and decoding.

FIG. 4 is a perspective view of a mobile computing device designated generally by

5   reference numeral 40. The mobile computing device 40 is similar to the mobile computing

device 10 shown by FIG. 1 except that imaging engine 12 is movably mounted to the housing

16 via a pivot or swivel mechanism 42 for changing the field of view of the movable imaging

engine 12 without moving the housing 16.

The swivel mechanism 42 includes a pair of mounts 44 protruding from the housing

10   16 and connected to the imaging engine 12 via a ball-and-socket connection 46, such that the

imaging engine 12 does not touch the housing 16, in order for the imaging engine 12 to

swivel in a top-down direction as shown by the arrow marked "A". Even though the swivel

mechanism 42 is shown in FIG. 4 as capable of moving the imaging engine 12 in a top-down

direction, the swivel mechanism 42 can be oriented on the housing 16 for moving the imaging

15   engine 12 in a left-right direction.

FIG. 5 is a perspective view of a mobile computing device designated generally by

reference numeral 50. In this embodiment, the imaging engine 12 is removably connected to

the housing 16 of the mobile computing device 52 via a lock/unlock mechanism 52. The

lock/unlock mechanism 54 is part of the housing 16 and it includes a space 55 for receiving

20   the imaging engine 12 and two pairs of protrusions 56 for locking and unlocking the imagine

engine 12 from the housing 16. Once the imaging engine 12 is removed from the housing 16,

the imaging engine 12 maintains communication with the circuitry within the mobile

computing device 50 via cable 58 which enters the housing 16. It is contemplated that

imaging engine 12 can maintain communication with the circuitry via a wireless connection.

In the embodiments shown by FIGS. 4 and 5, the field of view of the imaging engines

12, 14 can be changed without moving the housing 16 of the mobile computing devices 40,

50. These embodiments are useful in applications where one of the imaging engines is used

to image an object in one field of view and the other imaging engine is used to simultaneously

5   or successively image an object in another field of view. For example, in a video

teleconference application, one imagining engine can be used to image a document and the

other imaging engine can be used to image a conference participant.

It is contemplated that other combinations are possible to form additional

embodiments within the scope of the present invention. For example, one embodiment could

10   have one of the imaging engines movably mounted and removably connected to the housing.

Another embodiment could have one imaging engine movably mounted to the housing and

the other imaging engine removably connected to the housing.

The described embodiments of the present invention are intended to be illustrative

rather than restrictive, and are not intended to represent every embodiment of the present

15   invention. Various modifications and variations can be made without departing from the

spirit or scope of the invention as set forth in the following claims both literally and in

equivalents recognized in law.

<u>**IN THE CLAIMS**</u>:

1.   A computing device comprising:

a first imaging engine having an image sensor for sensing light and outputting a first plurality of signals corresponding to the sensed light;

5   a second imaging engine having an image sensor for sensing light and outputting a second plurality of signals corresponding to the sensed light;

switching circuitry for operatively switching between the first and second imaging engines; and

a processor for controlling the switching circuitry for receiving one of the first and 10   second plurality of signals.

2.   The computing device according to Claim 1, further comprising interface circuitry coupled to the switching circuitry and the processor for receiving the first and second plurality of signals from the switching circuitry and transmitting the signals to the processor.

15

3.   The computing device according to Claim 1, further comprising an automatically focusing lens assembly for automatically controlling movement of at least one lens of a lens assembly of at least one of the imaging engines.

20   4.   The computing device according to Claim 1, wherein the first imaging engine has a near-to-mid imaging range and the second imaging engine has a mid-to-far imaging range.

5.   The computing device according to Claim 1, wherein the imaging engines have at least one different depth of field and field of view.

6.   The computing device according to Claim 1, wherein at least one of the image sensors is a color image sensor.

7.   The computing device according to Claim 1, wherein the first image sensor includes a higher resolution photo detector array than the second image sensor.

8.   The computing device according to Claim 1, further comprising an aiming and illumination assembly controlled by the processor.

9.   The computing device according to Claim 1, wherein the switching circuitry includes a multiplexer.

10.   The computing device according to Claim 1, wherein the first and second imaging engines are configured and dimensioned to fit within a predetermined form factor.

11.   The computing device according to Claim 1, wherein the processor includes a set of programmable instructions for processing the plurality of signals to recognize and analyze data provided therein.

12.   The computing device according to Claim 1, wherein the computing device is selected from the group consisting of an optical code reader, a personal digital assistant

(PDA), a digital camera, a pager, a video telephone, a cellular telephone, a hand held

computer, and a hand held data capture device.

13.   The computing device according to Claim 1, wherein the first and second

5   imaging engines are supported by a housing.

14.   The computing device according to Claim 13, wherein at least one of the

imaging engines is movably mounted to the housing.

10   15.   The computing device according to Claim 14, wherein at least one of the

imaging engines is removably mounted to the housing.

16.   The computing device according to Claim 1, further comprising a user

selection assembly having a first control for manually selecting at least one operating mode of

15   the computing device, and a second control for manually selecting either the first or second

imaging engine.

17.   The computing device according to Claim 1, wherein the first and second

imaging engines are one of two individual imaging engines and one integrated imaging

20   engine.

18.   A computing device comprising:

at least two imaging engines each having an image sensor for sensing light and

outputting a plurality of signals corresponding to the sensed light;

switching circuitry for operatively switching between the at least two imaging

5   engines; and

a processor for controlling the switching circuitry and for processing the plurality of

signals.

19.   The computing device according to Claim 18, further comprising interface

10   circuitry coupled to the switching circuitry and the processor for receiving the plurality of

signals from the switching circuitry and transmitting the signals to the processor.

20.   The computing device according to Claim 18, further comprising an

automatically focusing lens assembly for controlling movement of at least one lens of a lens

15   assembly of at least one of the at least two imaging engines.

21.   The computing device according to Claim 18, at least one of the at least two

imaging engines has one of a near-to-mid imaging range and a mid-to-far imaging range.

20   22.   The computing device according to Claim 18, wherein the at least two imaging

engines have at least one different depth of field and field of view.

23.   The computing device according to Claim 18, wherein at least one of the at

least two imaging engines includes a color image sensor.

24. The computing device according to Claim 18, further comprising an aiming

and illumination assembly controlled by the processor.

5   25. The computing device according to Claim 18, wherein at least one of the at

least two imaging engines is configured and dimensioned to fit within a predetermined form

factor.

26. The computing device according to Claim 18, wherein the at least two imaging

10   engines are supported by a housing.

28. The computing device according to Claim 26, wherein at least one of the at

least two imaging engines is movably mounted to the housing.

15   29. The computing device according to Claim 26, wherein at least one of the at

least two imaging engines is removably mounted to the housing.

30. The computing device according to Claim 18, further comprising a user

selection assembly having a first control for manually selecting at least one operating mode of

20   the computing device, and a second control for manually selecting at least one of the at least

two imaging engines.

31. The computing device according to Claim 18, wherein the computing device is

selected from the group consisting of an optical code reader, a personal digital assistant

(PDA), a digital camera, a pager, a video telephone, a cellular telephone, a hand held

computer, and a hand held data capture device.

32.   A computing device comprising:

5   a first imaging engine having an image sensor for sensing light and outputting a first

plurality of signals corresponding to the sensed light;

        a second imaging engine having an image sensor for sensing light and outputting a

second plurality of signals corresponding to the sensed light; and

        a processor for receiving at least one of the first and second plurality of signals.

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33.   The computing device according to Claim 32, further comprising switching

circuitry for operatively switching between the first and second imaging engines.

34.   The computing device according to Claim 33, further comprising interface

15   circuitry coupled to the switching circuitry and the processor for receiving the first and second

plurality of signals from the switching circuitry and transmitting the signals to the processor.

35.   The computing device according to Claim 32, further comprising an

automatically focusing lens assembly for controlling movement of at least one lens of a lens

20   assembly of at least one of the imaging engines.

36.   The computing device according to Claim 32, wherein the first imaging engine

has a near-to-mid imaging range and the second imaging engine has a mid-to-far imaging

range.

37.   The computing device according to Claim 32, wherein the imaging engines

have at least one different depth of field and field of view.

5   38.   The computing device according to Claim 32, wherein at least one of the

image sensors is a color image sensor.

39.   The computing device according to Claim 32, wherein the first image sensor

includes a higher resolution photo detector array than the second image sensor.

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40.   The computing device according to Claim 32, further comprising an aiming

and illumination assembly controlled by the processor.

41.   The computing device according to Claim 33, wherein the switching circuitry

15   includes a multiplexer.

42.   The computing device according to Claim 32, wherein the first and second

imaging engines are configured and dimensioned to fit within a predetermined form factor.

20   43.   The computing device according to Claim 32, wherein the processor includes a

set of programmable instructions for processing the plurality of signals to recognize and

analyze data provided therein.

44.   The computing device according to Claim 32, wherein the computing device is

selected from the group consisting of an optical code reader, a personal digital assistant

(PDA), a digital camera, a pager, a video telephone, a cellular telephone, a hand held

computer, and a hand held data capture device.

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45.   The computing device according to Claim 32, wherein the first and second

imaging engines are supported by a housing.

46.   The computing device according to Claim 45, wherein at least one of the

10   imaging engines is movably mounted to the housing.

47.   The computing device according to Claim 45, wherein at least one of the

imaging engines is removably mounted to the housing.

15   48.   The computing device according to Claim 32, further comprising a user

selection assembly having a first control for manually selecting at least one operating mode of

the computing device, and a second control for manually selecting either the first or second

imaging engine.

20   49.   The computing device according to Claim 32, wherein the first and second

imaging engines are one of two individual imaging engines and one integrated imaging

engine.

50.   A method for performing digital imaging, the method comprising the steps of:

providing at least two imaging engines each having an image sensor for sensing light

and outputting a plurality of signals corresponding to the sensed light;

selecting at least one of the at least two imaging engines; and

5   processing the plurality of signals corresponding to the at least one selected imaging

engine.

51.   The method according to Claim 50, wherein the step of selecting is performed

either automatically or manually.

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52.   The method according to Claim 50, further comprising the step of

automatically controlling movement of a lens assembly of at least one of the at least two

imaging engines.

15   53.   The method according to Claim 50, wherein the step of providing at least two

imaging engines includes the step of providing at least one imaging engine configured and

dimensioned to fit within a predetermined form factor.

54.   The method according to Claim 50, wherein the step of processing includes

20   the step of decoding at least one optical code provided by the plurality of signals.
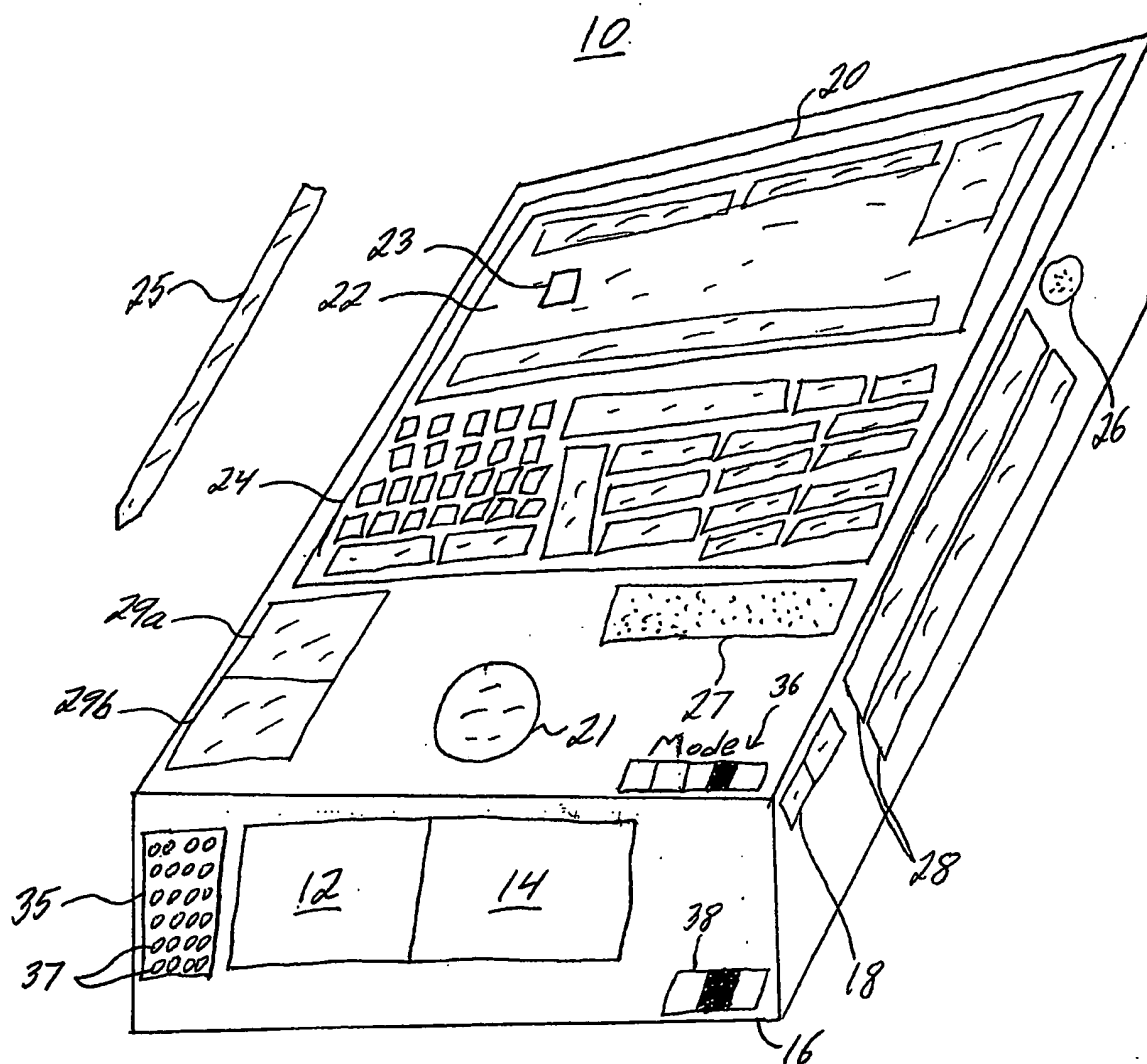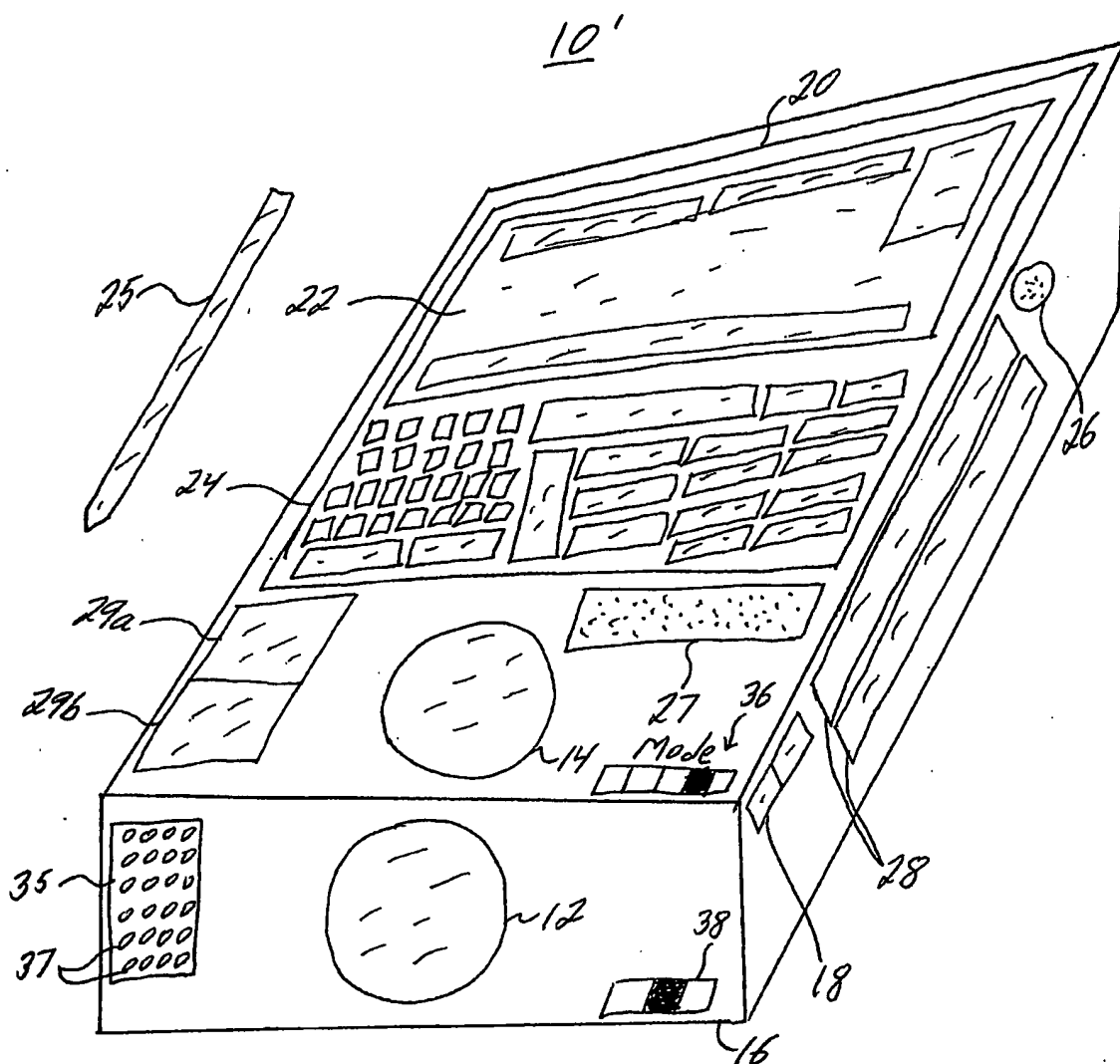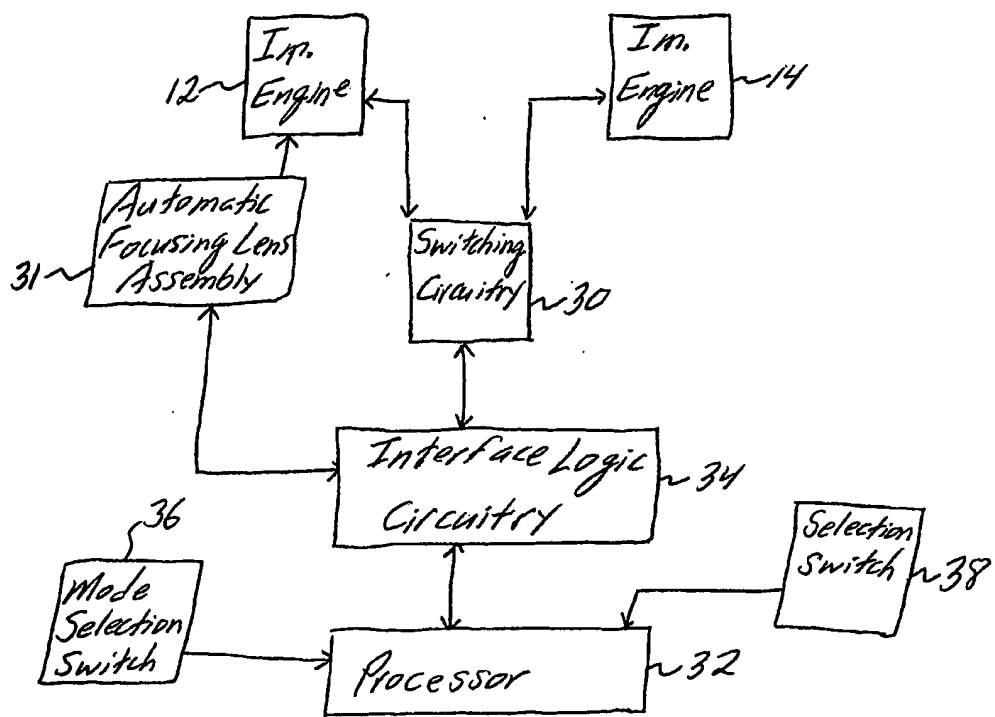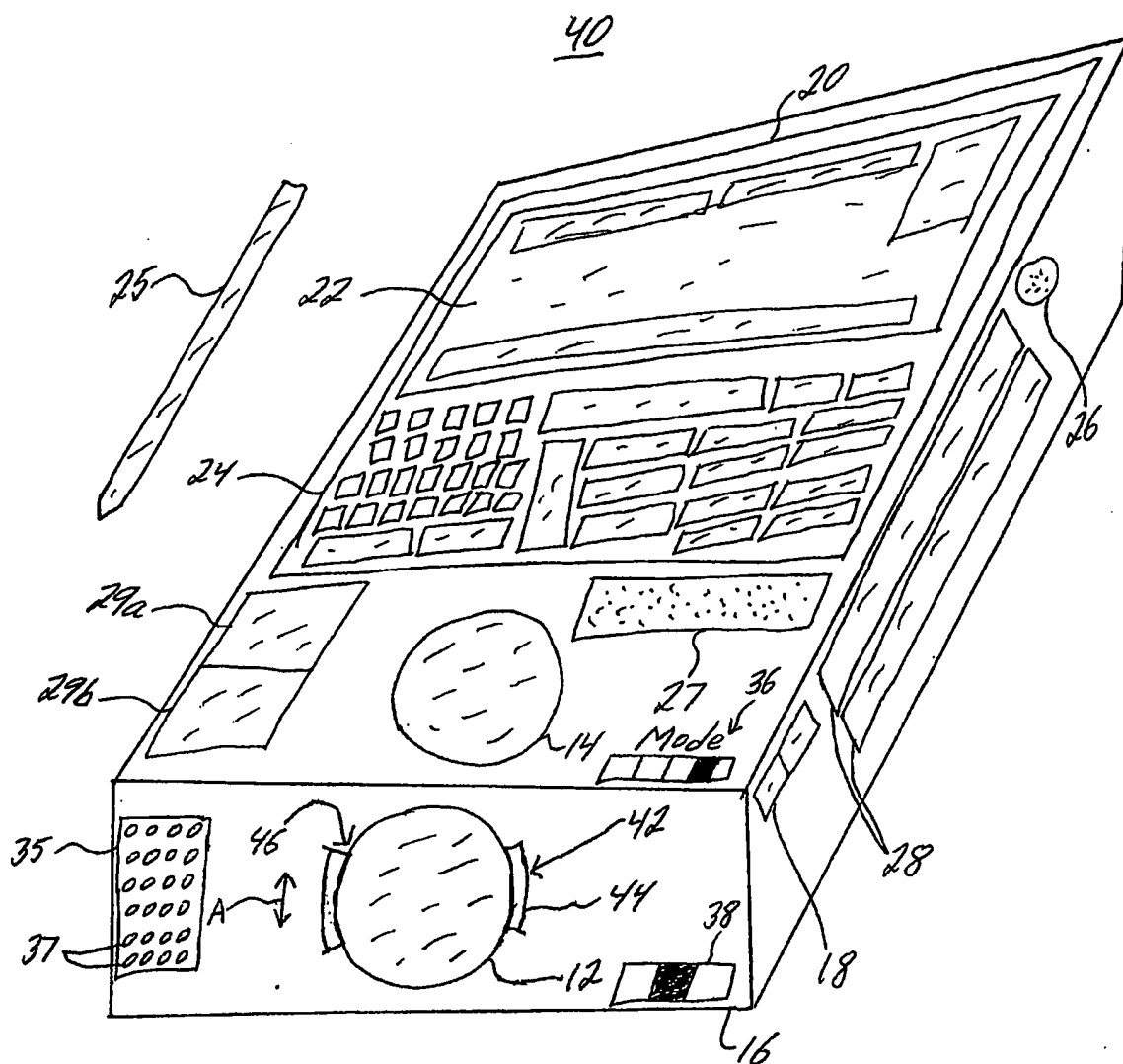
Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5